WHAT IS CLAIMED IS:

1. A method of measuring the surface motion of each portion of an object surface from a sequence of unit images of the object including first and second unit images, comprising the steps of:

determining a plurality of measurement points in an image of said object of a first unit image, said plurality of measurement points having a hierarchical structure of a plurality of levels, with the higher level layer including measurement points larger in number than the lower level layer;

determining the points in said object image of said second unit image, corresponding to the measurement points of said first unit image of the lowest level of the hierarchical structure of said plurality levels; and

repeating, starting from a level immediately upper than the lowest level to the highest level, the determination of the points corresponding to the measurement points of the first unit image at each level in the image of said object of said second unit image, based on the points corresponding to said measurement points of said first unit image at an immediately lower level of each level in the image of said object of said second unit image.

2. The method of measuring surface motion according to claim 1, wherein said step of determining measurement points includes the steps of

determining a plurality of reference points of said object image of said first unit image, and

determining, based on the plurality of reference points, arrangement of the measurement points having a predetermined distribution.

3. The method of measuring surface motion according to claim 2, wherein said step of determining the arrangement of the measurement points includes the step of mapping a plurality of points arranged at prescribed positions on a pre-selected prescribed three-dimensional plane in accordance with the three-dimensional shape of the object surface, to an image plane of said image, using the plurality of reference points as the reference.

4. The method of measuring surface motion according to claim 3, further comprising the step of

determining the three-dimensional position of said object by reverse-projecting, onto a prescribed three-dimensional plane, the points of the image of said object in the second unit image corresponding to said measurement points of said first unit image.

5. The method of measuring surface motion according to claim 3, wherein said step of determining the points corresponding to the measurement points includes the steps of

obtaining subband images by wavelet transform, with a plurality of resolutions of the same number as said plurality of levels, the object images of said first and second unit images, the plurality of resolutions being in correspondence with the plurality of levels and resolution corresponding to a lower level being selected to be lower;

determining the correspondence between the corresponding subband images of the lowest level and the measurement points of said lowest level, for said first unit image;

determining image segments having a prescribed relation with each of the measurement points of said lowest level of said subband images of said lowest level obtained for said first unit image; and

determining the positions of points in said second unit image, corresponding to each of the measurement points of said lowest level in said first unit image, by determining an image segment of said subband image of said lowest level obtained for said second unit image that represents the highest correlation with the texture of each said image segment.

6. The method of measuring surface motion according to claim 5, wherein said step of determining the points corresponding to said measurement points further includes the step of estimating the position of each of the measurement points at the level immediately higher than said lowest level by interpolating position of the point corresponding to each of

the measurement points at the lowest level.

7. The method of measuring surface motion according to claim 6, wherein said step of repeating includes the steps of repeating, starting from the level immediately higher than the lowest level to the highest level one by one, the steps for each level, including the steps of

regarding, for said first unit image, each of the points of which position is estimated for the level immediately lower than said each level as a measurement point of said each level,

determining an image segment having a prescribed relation with the measurement points of each level, in the subband image corresponding to said each level, and

determining, in said second unit image, a position of the point corresponding to each of the measurement points of each level of said first unit image, by determining the image segment of said subband image of the corresponding level obtained for said second unit image, that represents the highest correlation with the texture of each said image segment.

8. The method of measuring surface motion according to claim 7, wherein said step for each level further includes the step of estimating a position of a point corresponding to each of the measurement points of the level immediately above each said level, by interpolating a position of a point corresponding to each of the measurement points of each said level.

9. A method of measuring surface motion for measuring motion of each portion of an object from a sequence of unit images of the object including first and second unit images, comprising the steps of:

representing the position of each portion of the object surface in said first unit image by a mesh model including a plurality of nodes of which neighboring relations with each other are determined;

transforming the first and second unit images to a plurality of subband images with a predetermined plurality of resolutions;

generating, from said mesh model, a plurality of coarse mesh models

having node densities different from each other and lower than the node density of said mesh model, said plurality of coarse mesh models being in correspondence with the plurality of subband images;

obtaining overlay images by overlaying on said plurality of subband images of each of said first and second unit images, corresponding one of the plurality of coarse mesh models; and

calculating cross-correlation of the texture map of the overlay images obtained from the subband images corresponding to the first and second unit images, finding correspondence between each node of said mesh model of said first unit image with each node of the mesh model of said second unit image, and calculating relative change in position of each node from said first unit image to said second unit image.

10. The method of measuring surface motion according to claim 9, wherein said step of calculating includes the steps of

calculating cross-correlation of the texture map of said overlay images obtained from first subband images of said first and second unit images to find correspondence between first said coarse mesh model corresponding to said first subband image of said second unit image with each node of said first coarse mesh model corresponding to said first subband image of said first unit image, so as to calculate relative change in position of each node of said first coarse mesh model from said first unit image to said second unit image,

deforming a second coarse mesh model having node density higher than said first coarse mesh model, of said second unit image in accordance with change in position of each node of said first coarse mesh model, said second coarse mesh model being in correspondence with a second subband image having spatial frequency higher than that of said first subband image, and

calculating cross-correlation of the texture map of said overlay images obtained from said second subband images of said first and second unit images to find correspondence between each node of said second coarse mesh model corresponding to said first subband image of said second unit

image with each node of said second coarse mesh model corresponding to said second subband image of said first unit image, thereby calculating relative change in position of each node of said second coarse mesh model from said first unit image to said second unit image.

11. The method of measuring surface motion according to claim 10, wherein said calculation of cross-correlation is performed using an area defined by each node of said coarse mesh model as a center and surrounded by the nodes neighboring said center node as a search segment.

12. A computer readable recording medium storing a program for operating a computer to implement a method of measuring surface motion for measuring motion of each portion of an object surface from a sequence of unit images of the object including first and second unit images, wherein

said method of measuring surface motion includes the steps of

representing a position of each portion of said object surface in said first unit image by a mesh model including a plurality of nodes of which neighboring relations with each other are determined,

transforming said first and second unit images each to a plurality of subband images with a predetermined plurality of resolutions,

generating, from said mesh model, a plurality of coarse mesh models having node densities different from each other and lower than node density of said mesh model, said plurality of coarse mesh models being in correspondence with the plurality of subband images respectively, and

obtaining overlay images by overlaying on said plurality of subband images of each of said first and second unit images, corresponding one of said plurality of coarse mesh models.

13. The computer readable recording medium according to claim 12, wherein said step of calculating includes the steps of

calculating cross-correlation of the texture map of said overlay images obtained from first subband images of said first and second unit images to find correspondence between first said coarse mesh model

corresponding to said first subband image of said second unit image with each node of said first coarse mesh model corresponding to said first subband image of said first unit image, so as to calculate relative change in position of each node of said first coarse mesh model from said first unit image to said second unit image,

deforming a second coarse mesh model having node density higher than said first coarse mesh model, of said second unit image in accordance with change in position of each node of said first coarse mesh model, said second coarse mesh model being in correspondence with a second subband image having spatial frequency higher than that of said first subband image, and

calculating cross-correlation of the texture map of said overlay images obtained from said second subband images of said first and second unit images to find correspondence between each node of said second coarse mesh model corresponding to said first subband image of said second unit image with each node of said second coarse mesh model corresponding to said second subband image of said first unit image, thereby calculating relative change in position of each node of said second coarse mesh model from said first unit image to said second unit image.

14. The computer readable recording medium according to claim 13, wherein said calculation of cross-correlation is performed using an area defined by each node of said coarse mesh model as a center and surrounded by the nodes neighboring said center node as a search segment.

15. An apparatus for measuring a surface motion for measuring a motion of each portion of a surface of an object from a sequence of unit images of the object including first and second unit images, comparing:

means for representing a position of each portion of said object surface in said first unit image by a mesh model including a plurality of nodes of which neighboring relations with each other are determined;

means for transforming said first and second unit images each to a plurality of subband images with a predetermined plurality of resolutions;

means for generating, from the mesh model, a plurality of coarse mesh models having node densities different from each other and lower than node density of the mesh model, said plurality of coarse mesh models being in correspondence with the plurality of subband images, respectively;

means for obtaining overlay images by overlaying, on said plurality of subband images of each of said first and second unit images, corresponding one of said plurality of coarse mesh models; and

means for calculating cross-correlation of a texture map of said overlay images obtained from corresponding subband images of said first and second unit images to find correspondence between each node of said mesh model of said second unit image with each node of said mesh model of said first unit image, thereby calculating relative change in position of each node from said first unit image to said second unit image.

16. The apparatus for measuring surface motion according to claim 15, wherein said means for calculating includes

mean for calculating cross-correlation of a texture map of said overlay images obtained from said first subband images of said first and second unit images to find correspondence between each node of said coarse mesh model corresponding to said first subband image of said second unit image with each node of said first coarse mesh model corresponding to said first subband image of said first unit image, thereby calculating relative change in position of each node of said first coarse mesh model from said first unit image to said second unit image,

means for deforming a second coarse mesh model having node density higher than said first coarse mesh model of said second unit image in accordance with the change in position of each node of said first coarse mesh model, said second coarse mesh model being in correspondence to a second subband image having spatial frequency higher than said first subband image; and

means for calculating cross-correlation of the texture map of said overlay images obtained from said second subband images of said first and second unit images to find correspondence between each node of said second

coarse mesh model corresponding to said first subband image of said second unit image with each node of said second coarse mesh model corresponding to said second subband image of said first unit image, thereby calculating relative change in position of each node of said second coarse mesh model from said first unit image to said second unit image.

17. The apparatus for measuring surface motion according to claim 16, wherein said calculation of cross-correlation is performed using an area defined by each node of said coarse mesh model as a center and surrounded by the nodes neighboring said center node as a search segment.

18. A computer data signal embodied in a carrier wave and encoding a plurality of sequences of instructions, which, when executed by one or more processors, cause said one or more processors to configure an apparatus for measuring surface motion of an object, said plurality of sequences of instructions including sequences of instructions, which, when executed by said one or more processors, cause said one or more processors to perform the steps of:

determining a plurality of measurement points in an image of said object of a first unit image, said plurality of measurement points having a hierarchical structure of a plurality of levels, with the higher level layer including measurement points larger in number than the lower level layer;

determining points in said object image of said second unit image, corresponding to the measurement points of said first unit image of the lowest level of the hierarchical structure of said plurality levels; and

repeating, starting from a level immediately upper than the lowest level to the highest level, determination of the points corresponding to the measurement points of the first unit image, of each level, in the image of said object of said second unit image, based on the points corresponding to said measurement points of said first unit image at an immediately lower level of each level in the image of said object of said second unit image.

19. The computer data signal according to claim 18, wherein

said step of determining measurement points includes the steps of

determining a plurality of reference points of said object image of said first unit image, and

determining, based on the plurality of reference points, arrangement of the measurement points having a predetermined distribution.

20. The computer data signal according to claim 18, wherein

said step of determining arrangement of the measurement points includes the step of mapping a plurality of points arranged at prescribed positions on a pre-selected prescribed three-dimensional plane in accordance with the three-dimensional shape of the object surface, to an image plane of said image, using the plurality of reference points as the reference.

21. The computer data signal according to claim 20, wherein further comprising the step of

determining the three-dimensional position of said object by reverse-projecting, onto a prescribed three-dimensional plane, the points of the image of said object in the second unit image corresponding to said measurement points of said first unit image.

22. The computer data signal according to claim 20, wherein

said step of determining the points corresponding to the measurement points includes the steps of

obtaining subband images by wavelet transform, with a plurality of resolutions same in number as said plurality of levels, the object images of said first and second unit images, the plurality of resolutions being in correspondence with the plurality of levels and resolution corresponding to a lower level being selected to be lower;

determining correspondence between the corresponding subband images of the lowest level and the measurement points of said lowest level, for said first unit image;

determining image segments having a prescribed relation with each of the measurement points of said lowest level of said subband images of

said lowest level obtained for said first unit image; and

determining positions of points in said second unit image, corresponding to each of the measurement points of said lowest level in said first unit image, by determining an image segment of said subband image of said lowest level obtained for said second unit image that represents the highest correlation with the texture of each said image segment.

23. The computer data signal according to claim 21, wherein

said step of determining the points corresponding to said measurement points further includes the step of estimating position of each of the measurement points at the level immediately higher than said lowest level by interpolating position of the point corresponding to each of the measurement points at the lowest level.

24. The computer data signal according to claim 23, wherein

said step of repeating includes the steps of repeating, starting from the level immediately higher than the lowest level to the highest level one by one, the steps for each level, including the steps of

regarding, for said first unit image, each of the points of which position is estimated for the level immediately lower than said each level as a measurement point of said each level,

determining an image segment having a prescribed relation with the measurement points of each level, in the subband image corresponding to said each level, and

determining, in said second unit image, a position of the point corresponding to each of the measurement points of each level of said first unit image, by determining the image segment of said subband image of the corresponding level obtained for said second unit image, that represents the highest correlation with the texture of each said image segment.

25. The computer data signal according to claim 23, wherein

said step for each level further includes the step of estimating a position of a point corresponding to each of the measurement points of the

level immediately above each said level, by interpolating a position of a point corresponding to each of the measurement points of each said level.

26. A computer data signal embodied in a carrier wave and encoding a plurality of sequences of instructions which, when executed by one or more processors, cause said one or more processors to configure an apparatus for measuring surface motion of an object, said plurality of sequences of instructions including sequences of instructions, which, when executed by said one or more processors, cause said one or more processors to perform the steps of:

representing the position of each portion of the object surface in said first unit image by a mesh model including a plurality of nodes of which neighboring relations with each other are determined;

transforming the first and second unit images to a plurality of subband images with a predetermined plurality of resolutions;

generating, from said mesh model, a plurality of coarse mesh models having node densities different from each other and lower than the node density of said mesh model, said plurality of coarse mesh models being in correspondence with the plurality of subband images;

obtaining overlay images by overlaying on said plurality of subband images of each of said first and second unit images, corresponding one of the plurality of coarse mesh models; and

calculating cross-correlation of texture map of the overlay images obtained from the subband images corresponding to the first and second unit images, finding correspondence between each node of said mesh model of said first unit image with each node of the mesh model of said second unit image, and calculating relative change in position of each node from said first unit image to said second unit image.

27. The computer data signal according to claim 26, wherein said step of calculating includes the steps of

calculating cross-correlation of the texture map of said overlay images obtained from first subband images of said first and second unit

images to find correspondence between first said coarse mesh model corresponding to said first subband image of said second unit image with each node of said first coarse mesh model corresponding to said first subband image of said first unit image, so as to calculate relative change in position of each node of said first coarse mesh model from said first unit image to said second unit image,

deforming a second coarse mesh model having node density higher than said first coarse mesh model, of said second unit image in accordance with change in position of each node of said first coarse mesh model, said second coarse mesh model being in correspondence with a second subband image having spatial frequency higher than that of said first subband image, and

calculating cross-correlation of the texture map of said overlay images obtained from said second subband images of said first and second unit images to find correspondence between each node of said second coarse mesh model corresponding to said first subband image of said second unit image with each node of said second coarse mesh model corresponding to said second subband image of said first unit image, thereby calculating relative change in position of each node of said second coarse mesh model from said first unit image to said second unit image.

28. The computer data signal according to claim 27, wherein said calculation of cross-correlation is performed using an area defined by each node of said coarse mesh model as a center and surrounded by the nodes neighboring said center node as a search segment.